US007242387B2

(12) **United States Patent**
Fitzmaurice et al.

(10) **Patent No.: US 7,242,387 B2**
(45) **Date of Patent: Jul. 10, 2007**

(54) **PEN-MOUSE SYSTEM**

(75) Inventors: **George W. Fitzmaurice**, Toronto (CA); **Gordon Kurtenbach**, Toronto (CA); **William A Buxton**, Toronto (CA); **Robert J. Pieke**, Toronto (CA)

(73) Assignee: **Autodesk, Inc.**, San Rafael, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 427 days.

(21) Appl. No.: **10/684,581**

(22) Filed: **Oct. 15, 2003**

(65) **Prior Publication Data**

US 2004/0141015 A1 Jul. 22, 2004

Related U.S. Application Data

(60) Provisional application No. 60/419,144, filed on Oct. 18, 2002.

(51) **Int. Cl.**
G09G 5/08 (2006.01)
G06F 17/00 (2006.01)
G06F 3/00 (2006.01)

(52) **U.S. Cl.** **345/157**; 345/163; 345/173; 345/179; 715/711; 715/810; 715/856

(58) **Field of Classification Search** 345/163, 345/173, 179; 715/711, 714, 768, 773, 788, 715/799, 810, 831, 833, 815, 856–864
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,931,783 A 6/1990 Atkinson
5,276,795 A 1/1994 Hoeber et al.
5,581,670 A 12/1996 Bier et al.
5,627,960 A 5/1997 Clifford

(Continued)

OTHER PUBLICATIONS

Accot, J. Zhai, S. (2002), "More than dotting the I's —foundations for crossing-based interfaces", Proceedings of ACM CHI 2002, pp. 73-80.

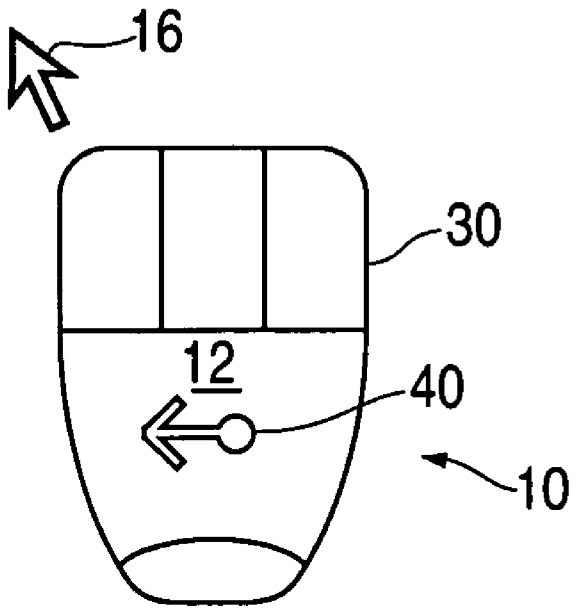
(Continued)

Primary Examiner—Henry N Tran
(74) *Attorney, Agent, or Firm*—Staas & Halsey LLP

(57) **ABSTRACT**

The present invention is a system that provides a pen based computer user with a graphical user interface tool, a pen-mouse, that looks like and functions like a mouse but that is controlled by a limited input device such as a pen or stylus of the pen based computer. The pen-mouse is a tracking menu that tracks the position of the pen. A pen cursor that corresponds to the pen is allowed to be moved about within the pen-mouse graphic by the pen and the pen-mouse remains stationary. The pen-mouse is moved when the location of the pen encounters a tracking boundary of the pen-mouse. The tracking boundary typically coincides with the graphic representing the mouse. While moving within the pen-mouse, the pen can select objects within the pen-mouse body, such as buttons, wheels, etc. The selection of a button or other virtual control causes a corresponding computer mouse button function to be executed. The execution focus is directed at any object designated by a pen-mouse tracking symbol, such as an arrow, that is part of the pen mouse graphic. The pen-mouse can emulate functions or operations of a mouse including single button clicks, double button clicks, finger wheels, track balls, etc.

13 Claims, 15 Drawing Sheets



U.S. PATENT DOCUMENTS

5,634,064	A		5/1997	Warnock et al.
5,638,523	A		6/1997	Mullet et al.
5,666,499	A	*	9/1997	Baudel et al. 715/808
5,689,667	A		11/1997	Kurtenbach
5,760,773	A	*	6/1998	Berman et al. 715/808
5,798,752	A		8/1998	Buxton et al.
6,097,387	A	*	8/2000	Sciammarella et al. 715/784
6,118,427	A		9/2000	Buxton et al.
6,246,411	B1		6/2001	Strauss
6,262,719	B1	*	7/2001	Bi et al. 345/179
6,369,837	B1		4/2002	Schirmer
6,549,219	B2		4/2003	Selker
6,865,719	B1		3/2005	Nicholas, III
6,918,091	B2		7/2005	Leavitt et al.
6,938,221	B2		8/2005	Nguyen
2001/0009428	A1		7/2001	Dow et al.

OTHER PUBLICATIONS

Bier, E. A., Stone, M.C., Fishkin, K., Buxton, W., Baudel, T., (1994), "A Taxonomy of See Through Tools", Proceedings of the ACM CHI 1994, pp. 358-364.

Buxton, W., (1990), "A Three-State Model of Graphical Input", In D., Diaper et al. (Eds), Human-Computer Interaction—INTERACT '90., Amsterdam: Elsevier Science Publishers B.V., (North-Holland), pp. 449-456.

Buxton, W., Fitzmaurice, G., Balakrishnan, R., and Kurtenbach, G. (200), "From Traditional to Electronic Large Displays in Automotive Design", IEEE Computer Graphics and Applications, 20(4), pp. 68-75.

Callahan, J., Hopkins, D., Weiser, M. & Shneiderman, B. (1988), "An Empirical Comparison of Pie vs. Linear Menus", Proceedings of CHI '88, pp. 95-100.

Elrod, S., Bruce, R., Gold, R., Goldberg, D., Halasz, EG., Janssen, Jr., W. C., Lee, D., McCall, K., Pedersen, E.R., Pier, K.A., Tang., and Welch, B., (1992), "Liveboard: A Large Interactive Display Supporting Group Meetings, Presentations, and Remote Collaboration", Proceedings of ACH CHI 1992, pp. 599-607.

Guimbretiere, F., Stone, M. & Winograd, T., (2001), "Fluid Interaction with High-Resolution Wall-size Displays", Proceedings of ACM UIST 2001, pp. 21, 30.

Guimbretiere, F., and Winograd, T., (2000), "FlowMenu: Combining Command, Text, and Data Entry", Proceedings of ACM UIST 2000, pp. 213-216.

Harrison, B., Kurtenbach, G., Vincente, K., (1995), "An Experiment Evaluation of Transparent User Interface Tools and Information Content", Proceedings of ACM UIST, 1995, pp. 81-90.

Harrision, B., Fishkin, K., Gujar A., Mochan, C., Want, R. (1998), "Squeeze me, hold me, tilt me! An Exploration of Manipulative User Interfaces", Proceedings of ACM CHI 1998, pp. 17-24.

Kramer, A., (1994), "Translucent Patches: Dissolving Windows", Proceedings of ACM UIST 1994, pp. 121-130.

Kurtenbach, G. & Buxton, W., (1993), "The limits of expert performance using hierarchical marking menus", Proceedings of the ACM CHI 1993, pp. 482-487.

Kurtenbach, G., Fitzmaurice, G., Baudel, T., Buxton, B., (1997), "The Design of a GUI Paradigm based on Tablets, Two-Hands, and Transparency", Proceedings of ACH CHI 1997, pp. 35-42.

Kurtenbach, G., (1993), The Design and Evaluation of Marking Menus, Ph.D., thesis, University of Toronto, Dept. of Computer Science.

Pook, S., Lecolinet, E., Vaysseix, G., and Barillot,, E. (2000), "Control Menus: Execution and Control in a Single Interactor", Proceedings of ACH CHI 2000 Extended Abstracts, pp. 263-264.

Rubio, J. M. and Janacek, P. (2002), "Floating Pie Menus: Enhancing the functionality of Contextual Tools", Proceedings of ACM UIST 2002 Conference Companion, pp. 39-40.

Venolia, D. and Neiberg, F. (1994), "T-Cube: A Fast, Self-Disclosing Pen-Based Alphabet", Proceedings of ACH CHI 1994, pp. 265-270.

Hopkins, D. (1991), "The Design and Implementation of Pie Menus", Dr. Dobbs Journal, 16(12), pp. 16-26.

Bederson, B.B. and Hollan, J. D. (1994), "Pad++: A Zooming Graphical Interface for Exploring Alternative Interface Physics", Proceedings of ACM UIST 1994, pp. 17-26.

Perlin, K. and Fox, D. (1993), "Pad: An Alternative Approach to the Computer Interface", Proceedings of ACM SIGGRAPH 1993, pp. 57-64.

MacKenzie, I.S. & Buxton, W. (1994), "Prediction of Pointing and Dragging Times in Graphical User Interfaces Interacting With Computer", 6(4), pp. 213-227.

Myers, B. & Buxton, W. (1986), "Creating Highly-Interactive and Graphical User Interfaces by Demonstration", Computer Graphics 20(3), Proceedings of SIGGRAPH '18, pp. 249-258.

Fitzmaurice et al., "Tracking Menus", Alias|Wavefront, pp. 1-10.

Fitzmaurice et al., "Tracking Menus", Proceedings from ACM CHI 2003, vol. 5, Issue 2, pp. 71-80.

* cited by examiner

FIG. 1

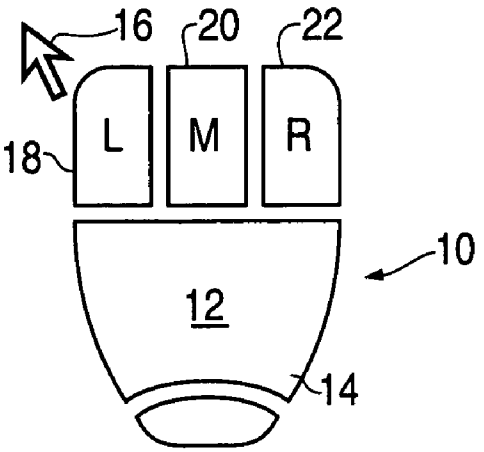


FIG. 2

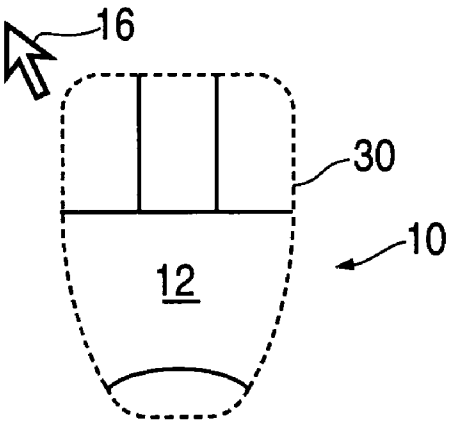
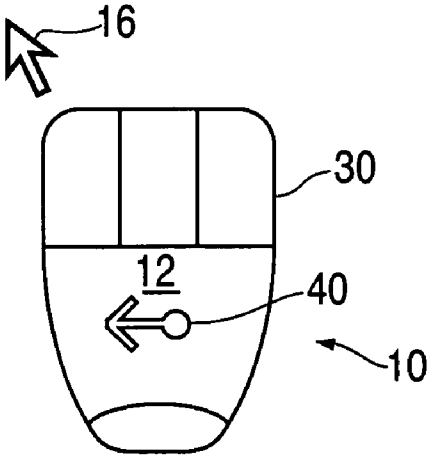


FIG. 4



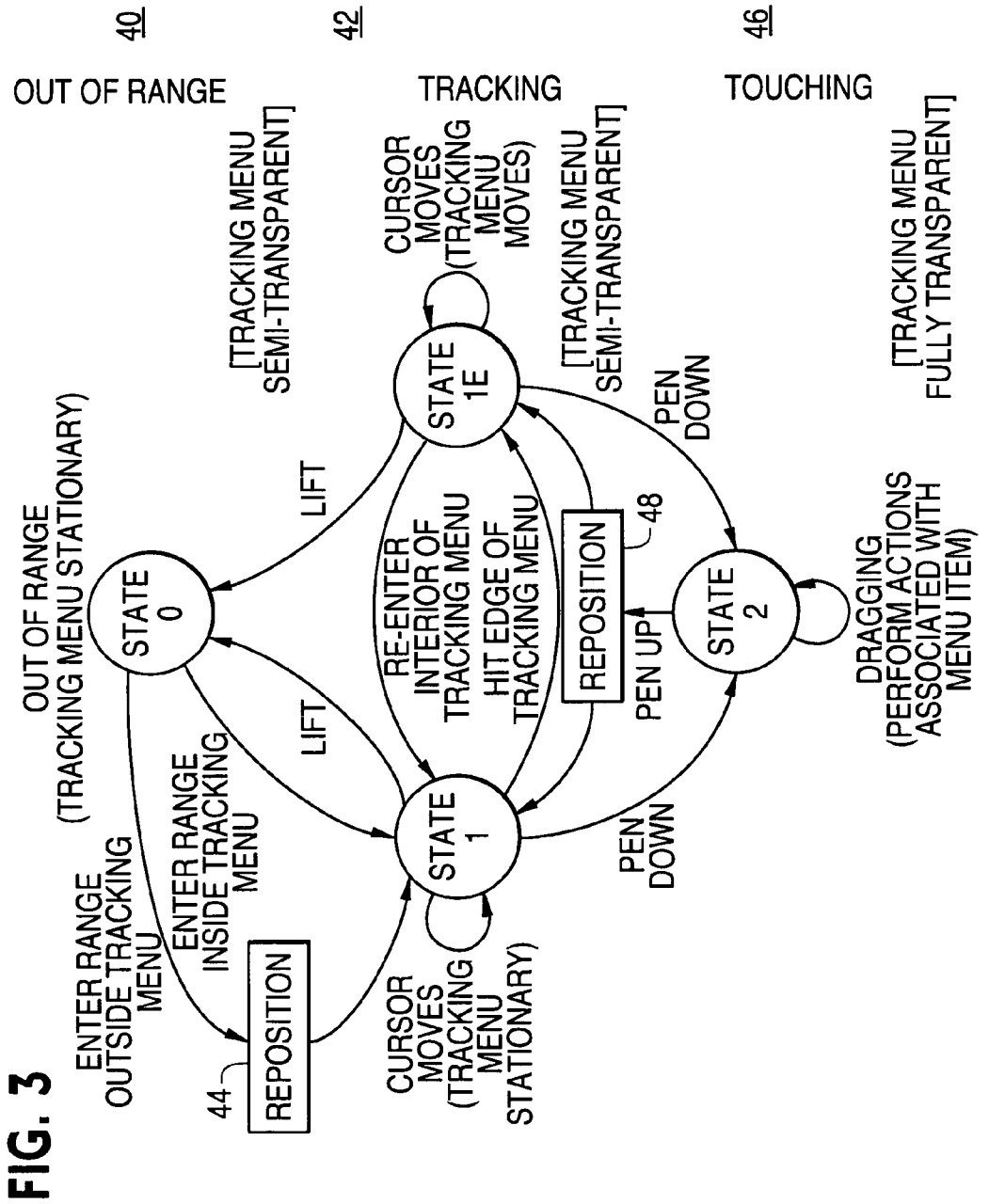

40
42
46
OUT OF RANGE
TRACKING
TOUCHING
STATE 0
STATE 1
STATE 1E
STATE 2
OUT OF RANGE (TRACKING MENU STATIONARY)
ENTER RANGE OUTSIDE TRACKING MENU
ENTER RANGE INSIDE TRACKING MENU
REPOSITION
44
[TRACKING MENU SEMI-TRANSPARENT]
LIFT
CURSOR MOVES (TRACKING MENU STATIONARY)
CURSOR MOVES (TRACKING MENU MOVES)
RE-ENTER INTERIOR OF TRACKING MENU
HIT EDGE OF TRACKING MENU
REPOSITION
48
PEN UP
PEN DOWN
[TRACKING MENU SEMI-TRANSPARENT]
PEN DOWN
[TRACKING MENU FULLY TRANSPARENT]
DRAGGING (PERFORM ACTIONS ASSOCIATED WITH MENU ITEM)

FIG. 3

FIG. 5

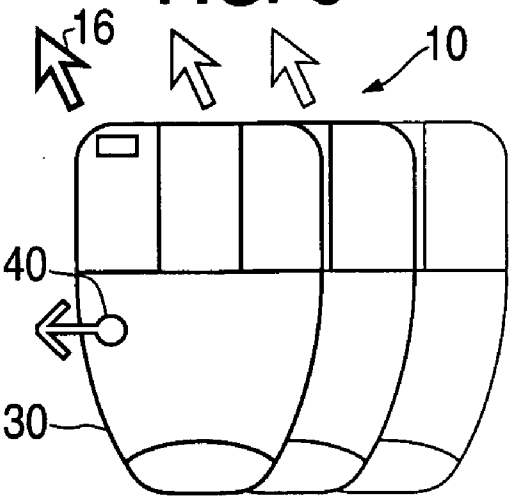


FIG. 6

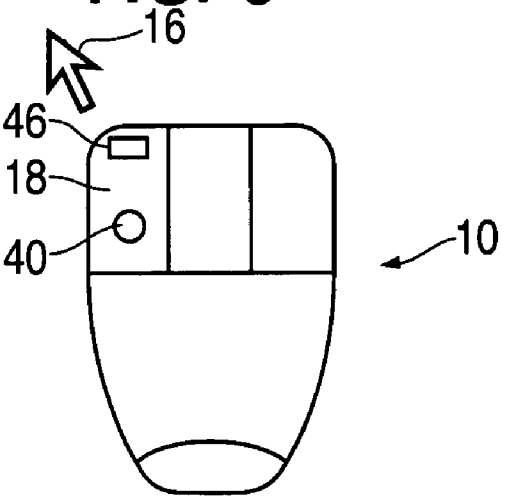


FIG. 7

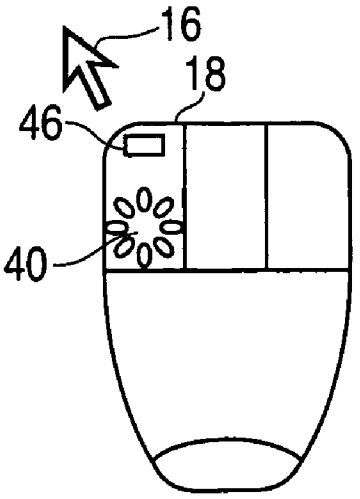


FIG. 8

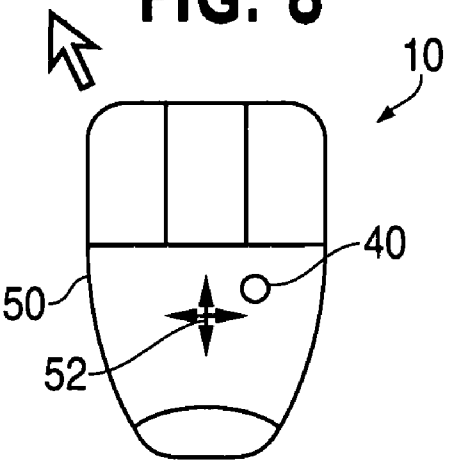


FIG. 9

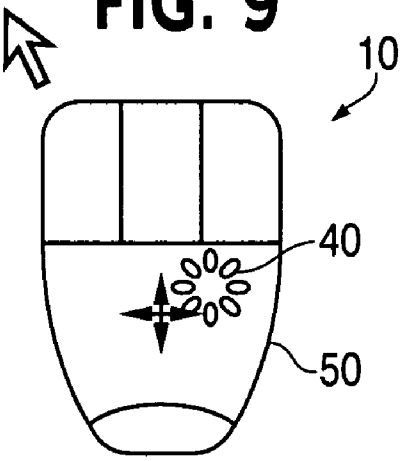


FIG. 10

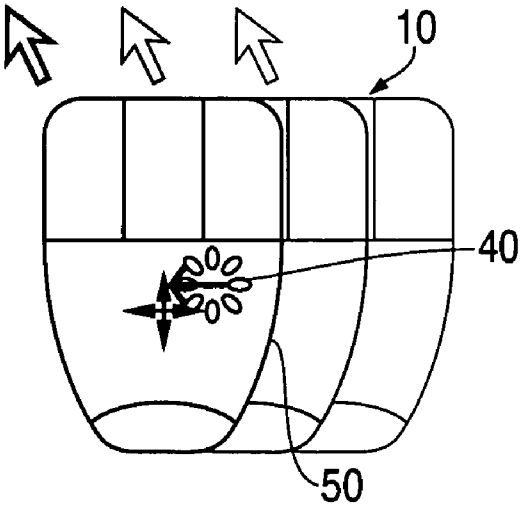


FIG. 11

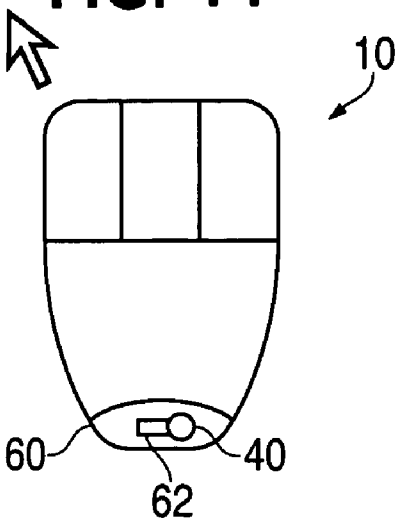


FIG. 12

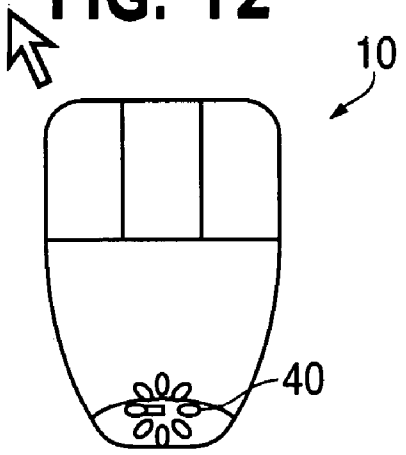


FIG. 13

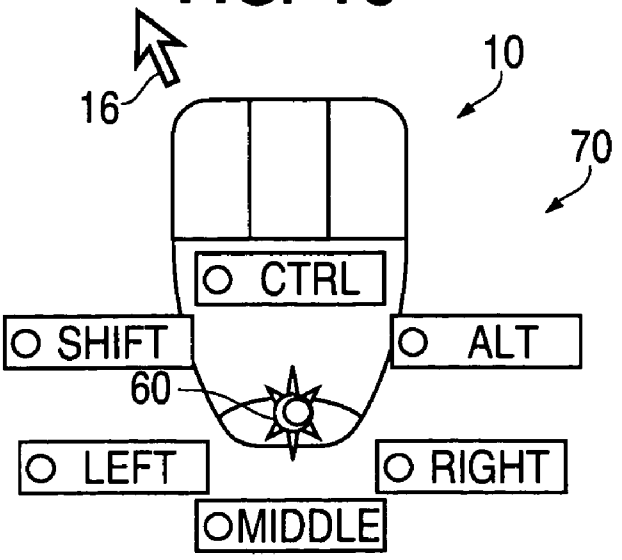


FIG. 14

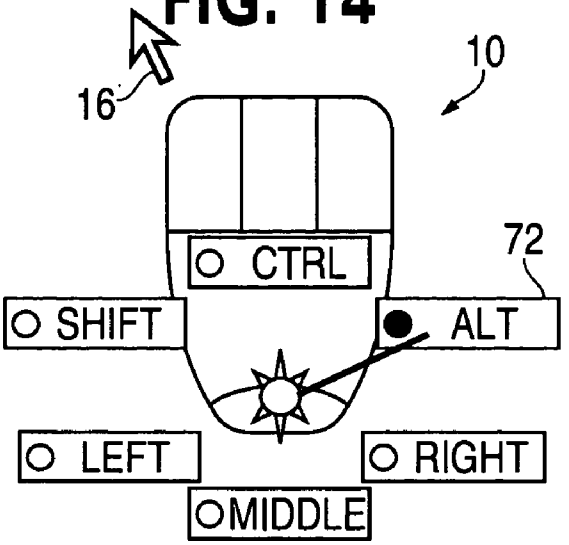


FIG. 15

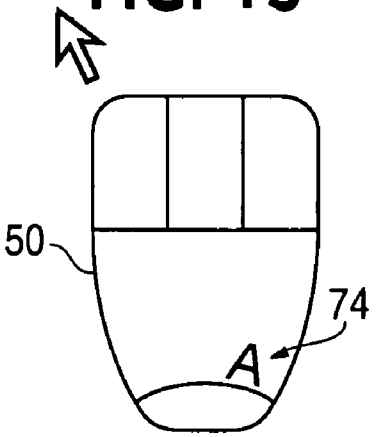


FIG. 16

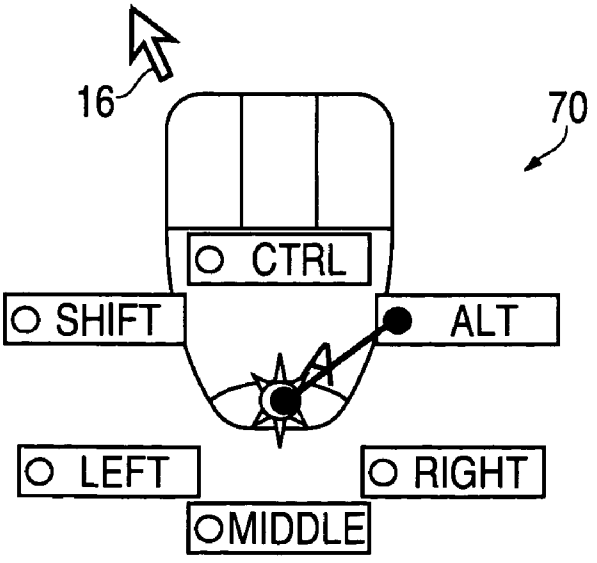


FIG. 17

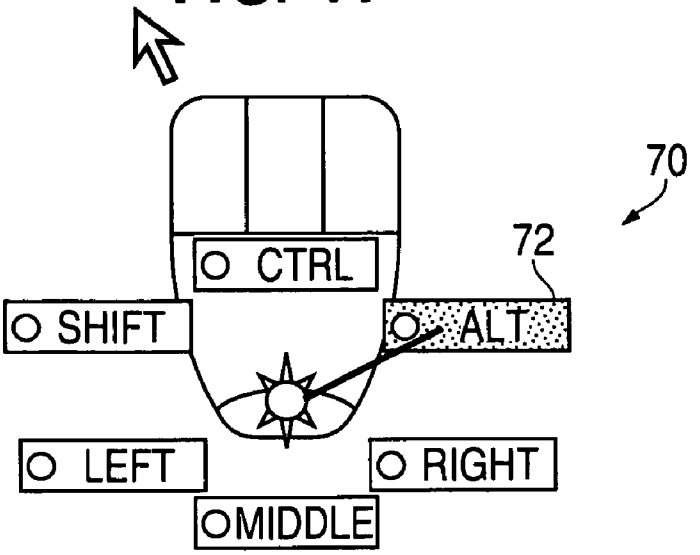


FIG. 18

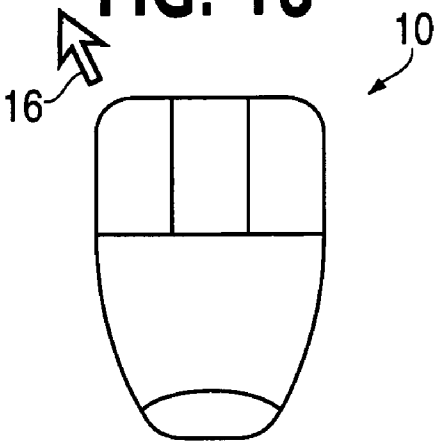


FIG. 19

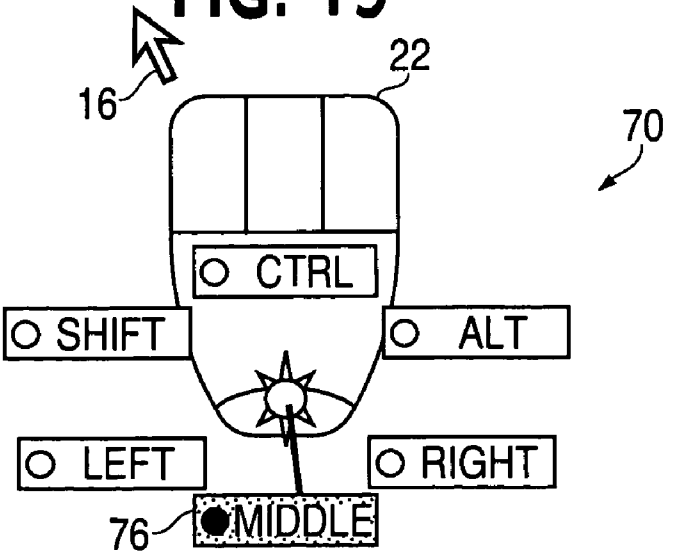


FIG. 20

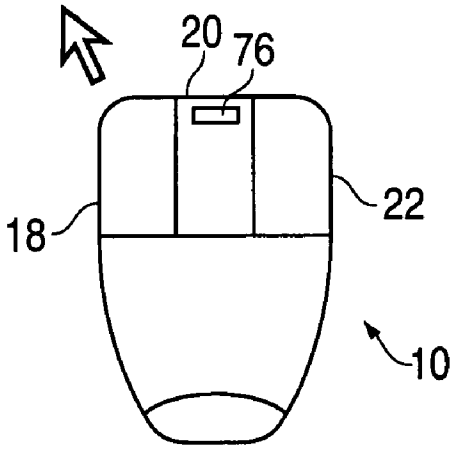


FIG. 21

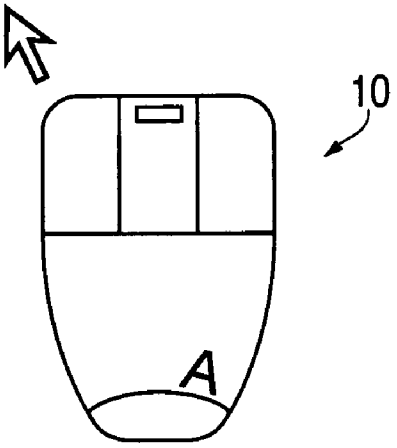


FIG. 22

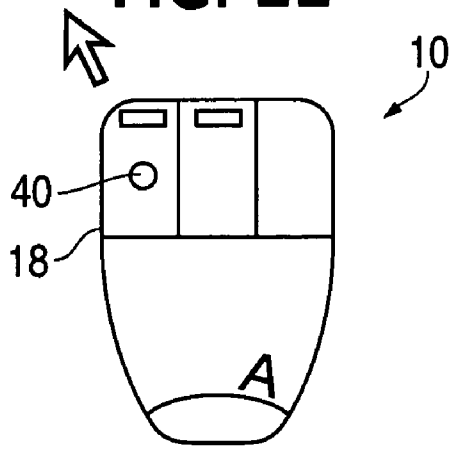


FIG. 23

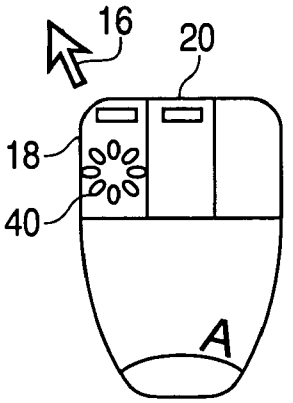

16
20
18
40
A

FIG. 36

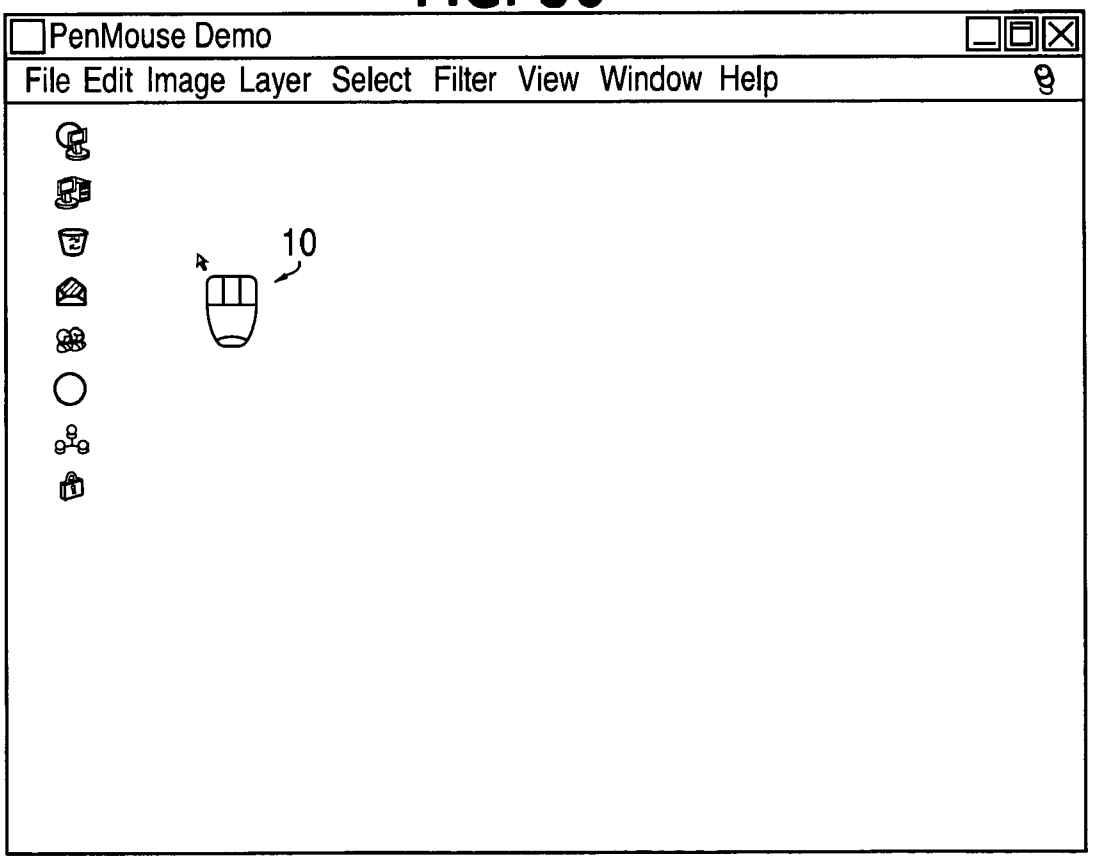

PenMouse Demo
File Edit Image Layer Select Filter View Window Help
10

FIG. 24

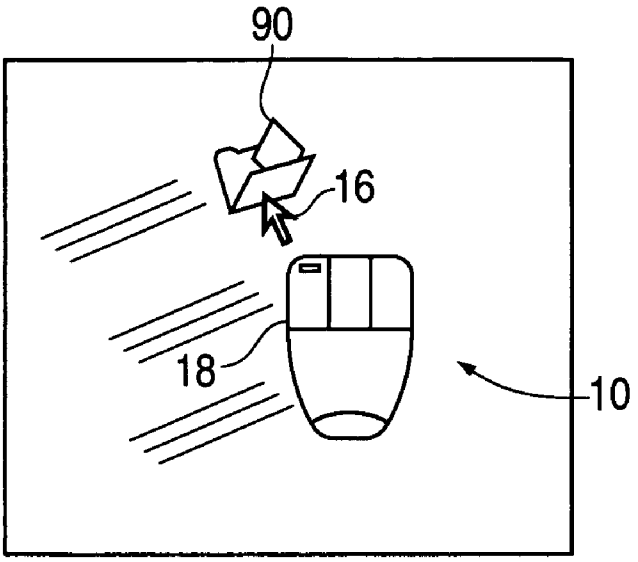


FIG. 25

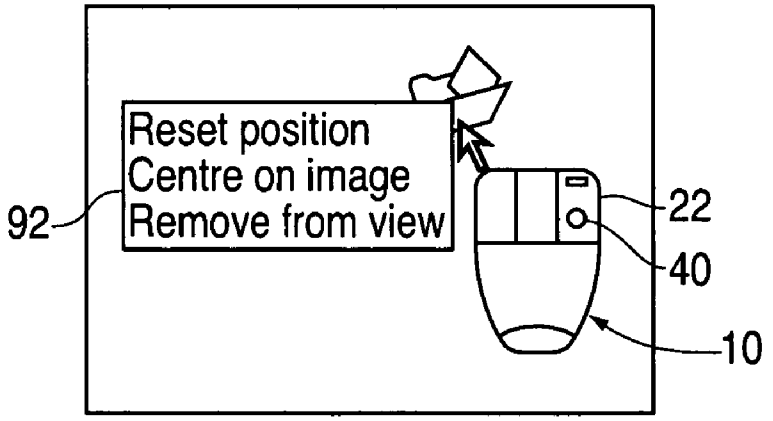


FIG. 26

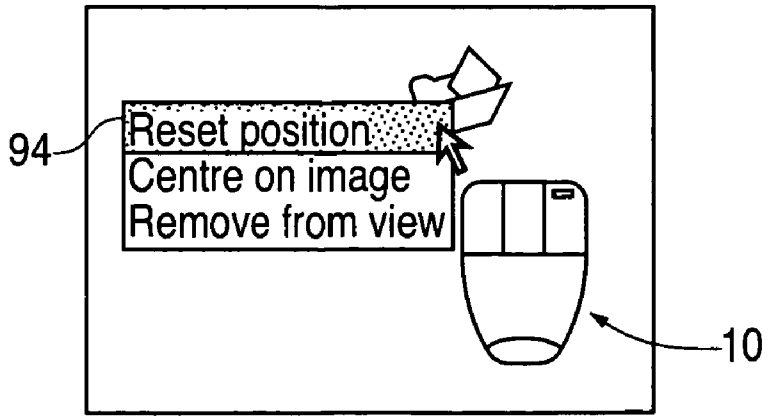


FIG. 27

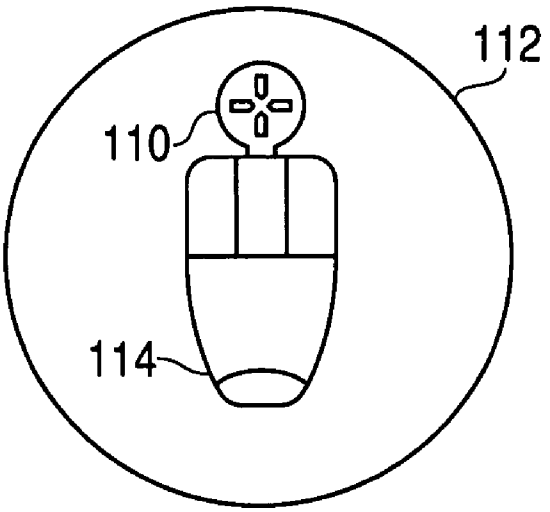


FIG. 29

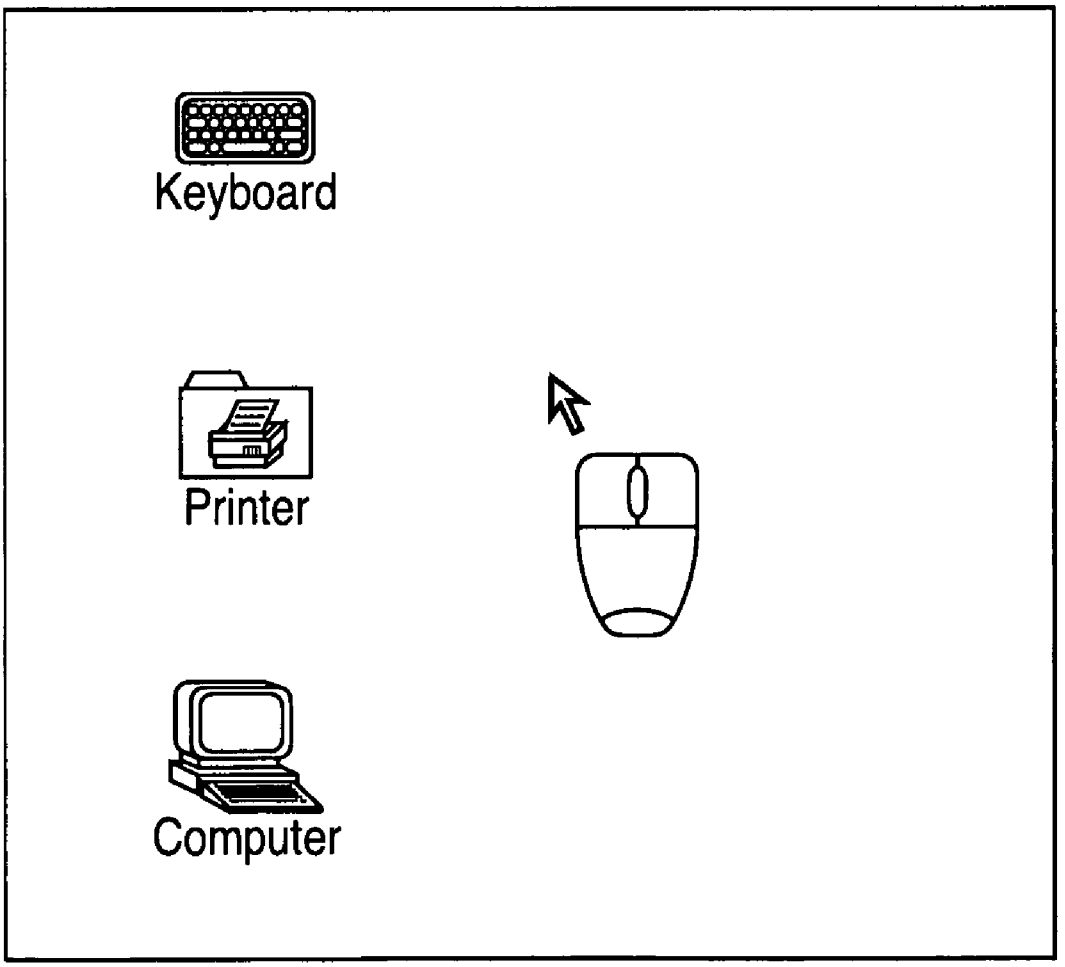


FIG. 28a

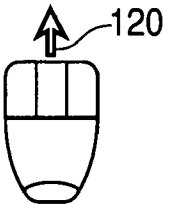


FIG. 28b

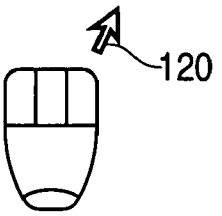


FIG. 28c

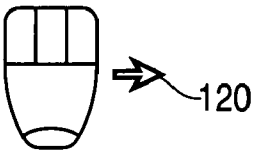


FIG. 28d

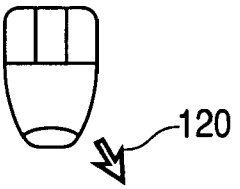


FIG. 28e

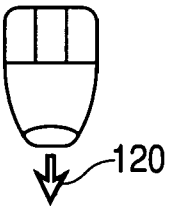


FIG. 28f

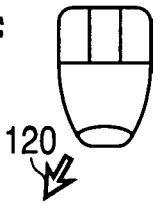


FIG. 28g

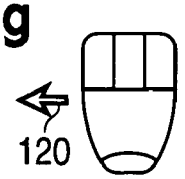


FIG. 30

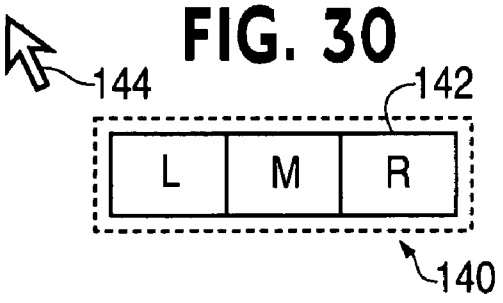


FIG. 31

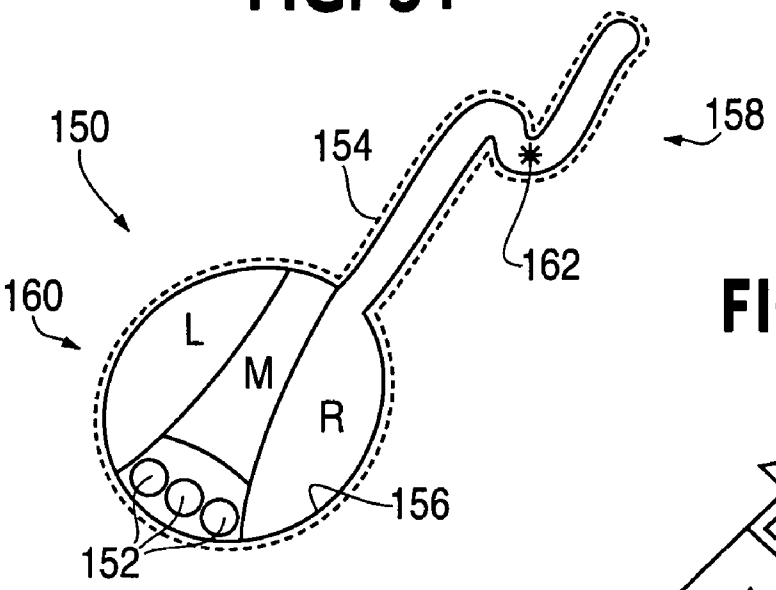


FIG. 32

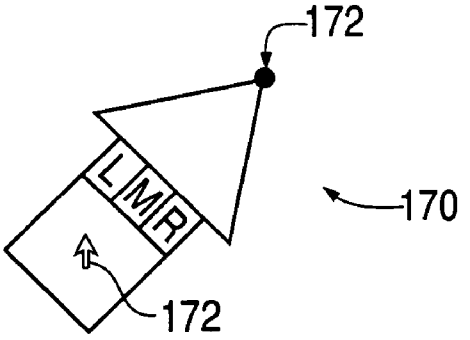


FIG. 33

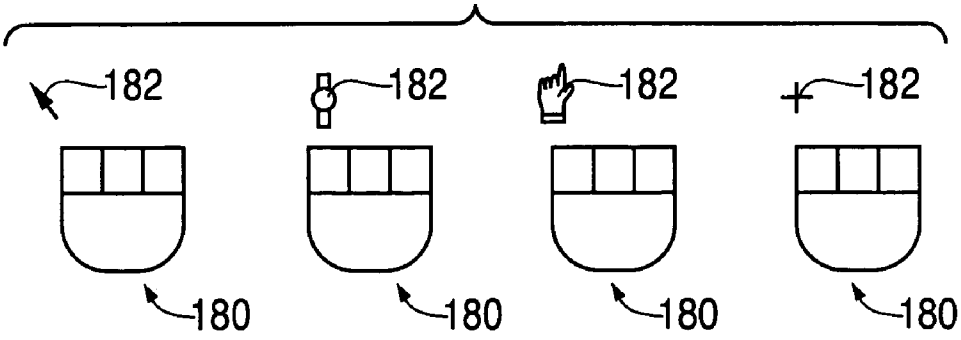


FIG. 34

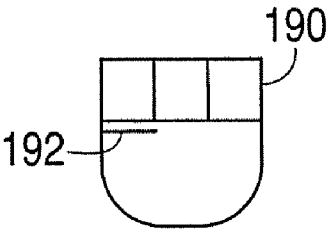


FIG. 35

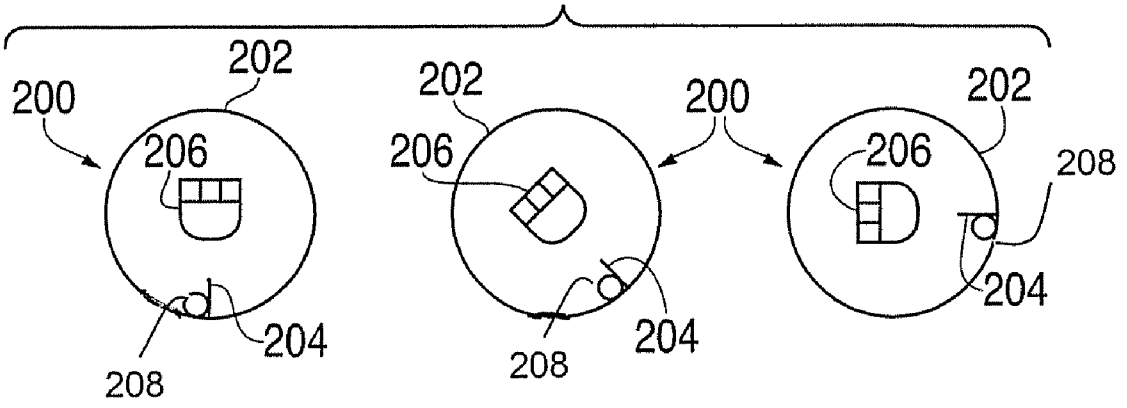


FIG. 37

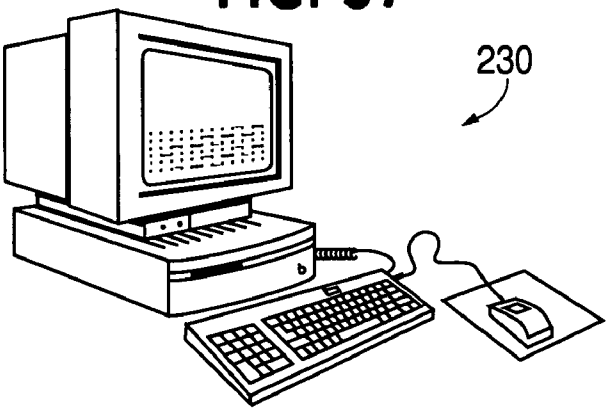


FIG. 38

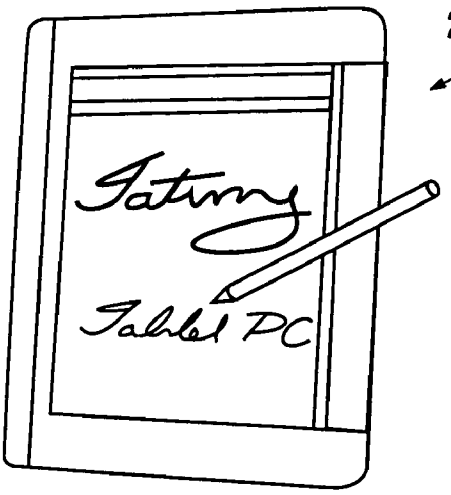
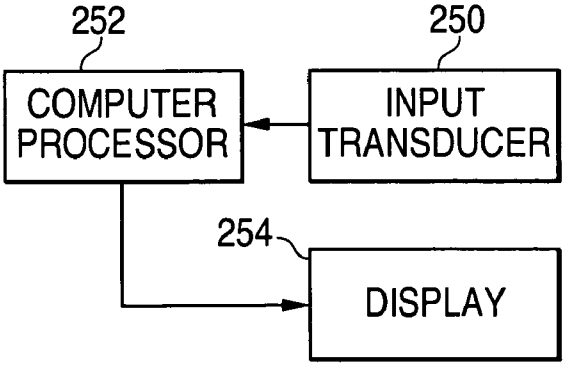


FIG. 39



PEN-MOUSE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is related to and claims priority to U.S. provisional application entitled Tracking Menu System having Ser. No. 60/419,144, by Fitzmaurice et al, filed Oct. 18, 2002, this application is also related to U.S. application entitled Tracking Menu, System and Method having Ser. No. 10/684,580, by Fitzmaurice et al, filed Oct. 15, 2003 and to U.S. application entitled Pan-Zoom Tool having Ser. No. 10/684,579, by Fitzmaurice et al, filed Oct. 15, 2003, all of which are incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a tracking menu that can be used with a pen based computer and that provides a pen user the functionality of a mouse and, more particularly, to a pen-mouse that tracks a position of a pen or stylus, allows pointing like a mouse and emulates the functionality of mouse buttons and other mouse inputs, such as a finger rollable wheel.

2. Description of the Related Art

Stylus or pen-based computers, such as tablet (personal computers) PCs and personal digital assistants (PDAs) are becoming a popular type of computing device. These devices operate somewhat differently than the typical mouse-based computer systems. In the pen-based devices the user uses a stylus or pen to select and activate items, such as menu controls/buttons, as well as to perform graphic functions, such as drawing. In performing these different operations it is often the case that the user must move the pen to a menu to select a function and then return to the display area to perform the function. Because these pen-based operations are somewhat different from traditional mouse based operations, it can be helpful to a new user to have a familiar paradigm, such as a mouse, that can be used in pen-based computers to perform mouse type operations.

What is needed is an interface that provides a user with the look and "feel" of operation of a mouse and avoids the need to move to a menu to select mouse functions, such as left button, right button, scroll, etc.

SUMMARY OF THE INVENTION

It is an aspect of the present invention to provide a graphical user interface that emulates a mouse input device and is controlled by a pen of a pen based computer.

It is another aspect of the present invention to provide a mouse emulation that functions as a tracking menu.

It is also an aspect of the present invention is to provide mouse emulation that does not use keyboard events/signals but does emulate some keyboard keys (e.g., shift/alt)

The above aspects can be attained by a system that provides a pen based computer user with a tool, a pen-mouse, that functions like a mouse but that is controlled by a limited input device, such as a pen or stylus. The pen-mouse is a tracking menu that tracks the position of the pen. A pen-cursor that corresponds to the pen is allowed to move about within a pen-mouse graphic. The pen-mouse is moved when the location of the pen, pen cursor or pen transducer sensed position encounters a tracking boundary of the pen-mouse. While moving within the pen-mouse the pen can select objects within the pen-mouse such as buttons, wheels, etc. The selection of a button or other virtual control causes a corresponding mouse button function to be executed. The execution focus is directed at any object designated by a tracking symbol, such as an arrow, that is part of the pen-mouse graphic.

These together with other aspects and advantages which will be subsequently apparent, reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a pen-mouse tracking menu according to the present invention.

FIG. **2** depicts a tracking border of the pen-mouse.

FIG. **3** illustrates tracking states.

FIG. **4** shows a pen cursor moving within the pen-mouse.

FIG. **5** shows the pen cursor moving the pen-mouse.

FIGS. **6** and **7** show a button being highlighted and selected.

FIGS. **8**–**10** depict the pen-mouse during pan tracking.

FIGS. **11** and **12** show the pen-mouse bar function highlighted and activated.

FIGS. **13**–**23** show marking menu activation and double button function activation

FIG. **24** shows object dragging with the pen-mouse.

FIGS. **25** and **26** depict linear menu activation and selection.

FIG. **27** illustrates a tracking boundary not coinciding with the body graphic.

FIGS. **28***a*–**28***g* illustrate different positions for the pen-mouse tracking symbol.

FIG. **29** depicts a different pen-mouse graphic with a wheel function.

FIG. **30** shows a limited function and a limited graphic pen-mouse.

FIG. **31** shows a pen-mouse with activation safety features.

FIG. **32** shows an arrow shaped pen-mouse.

FIG. **33** shows pen-mouse tracking symbols changing according to system state.

FIG. **34** shows an interior tracking wall.

FIG. **35** shows a wall being used to provide track ball functionality.

FIG. **36** shows pen-mouse relative size.

FIG. **37** shows a desktop PC as hardware of the present invention.

FIG. **38** depicts a tablet PC as hardware of the present invention.

FIG. **39** shows components of the hardware of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed to a user interface, particularly, a graphical user interface (GUI) that has the appearance of a mouse **10** as depicted in FIG. **1**. This interface **10**, which for convenience will be called a pen-mouse, is a tracking menu where the pen-mouse **10** tracks the position of a stylus or pen being used with a pen-based computer. A tracking menu is a graphical user interface widget that is controlled by either a pen or mouse having an associated pen or mouse cursor where the cursors can be invisible. A tracking menu is invoked and dismissed in the

same manner as a traditional modal tool by clicking on a tool palette or menu item. Like traditional menus, a tracking menu includes a cluster of graphical buttons or controls. The pen cursor can be moved within the menu to select and interact with items, such as the buttons. However, unlike traditional menus, when the pen cursor crosses the exterior edge or tracking boundary of the menu, the menu is moved to keep it under the cursor. The pen-mouse tracking menu, of the present invention, can track other types of input devices, such as a finger in a touch based menu, a traditional mouse and 3D input devices such as gloves. Additional details with respect to tracking menus can be found in the related application noted above.

The pen-mouse **10** preferably includes a mouse graphic **12** that includes a visible border or edge **14** and a traditional arrow cursor or tracking symbol **16**. This pen-mouse tracking menu **10** tracks the position of the pen of the pen based computer system as will be discussed later in more detail. By moving the pen, the cursor **16** can be positioned to point at an object in the same way that a cursor for a mouse is positioned to point at an object. The mouse graphic **12** depicts three buttons **18** (left—L), **20** (middle—M) and **22** (right—R) that are conventional type virtual controls specifically for initiating mouse button down events when activated by a pen down event with the pen tip positioned over one of the buttons **18**–**22**. The tracking symbol or cursor **16** behaves like a traditional tracking symbol used with a mouse where the tracking symbol can point at (be positioned over) an object, such as a menu, and activate the object when a mouse down event occurs. That is, conventional input mapping based on location of an input sensor or cursor are performed. As a result, when the cursor **16** is positioned over an activatable object and a pen down event occurs with the pen located over one of the buttons **18**–**22**, a mouse down event for the corresponding mouse button occurs for the object at which the cursor points. In this way, the pen of the pen-based computer system can be used to perform the same functions as a mouse in a mouse based computer system.

The pen-mouse tracking menu **10**, as depicted in FIG. **2**, includes a tracking menu tracking boundary **30** that allows the pen cursor **16** to move within the tracking menu **10** without causing the menu to pen-mouse **10** to move with the movement of the pen. The boundary **30** is shown as coinciding with the visible edge of the graphic **12** but need not be so coincident (see FIG. **27**).

The operation of the pen-mouse tracking menu **10** of the present invention can be understood using a state diagram as depicted in FIG. **3**. In state 0 the pen is out-of-range **40** of the tracking system of the pen based computer, such as a tablet PC, and the tracking menu **10** is visible (preferably semi-transparent) and is positioned in the last place it resided before the pen moved out-of-range or in an initial position if the tracking menu has just been involved. The state 0 is entered from states 1 and 1E when the pen is lifted from the tablet and moved out-of-range. The menu **10** resides in this last position until the pen is brought back into range and the tablet PC begins tracking the pen.

The pen can move into tracking range **42** and enter state 1 in two different ways. In the first into-range transition, the pen comes down at a position where the tip of the pen is outside of the tracking menu edge or tracking boundary **30**. When tracking starts in this condition, the menu **10** is moved or repositioned **44** so that the cursor is inside the menu edge. This involves conventionally redrawing the semi-transparent menu **10** at a position corresponding to the pen tip, cursor or sensed pen transducer position. This repositioning or redrawing can place the menu **10** such that the menu **10** is moved the minimum distance to place the pen cursor just within the edge of the menu **10**. Or the repositioning can place the menu at an arbitrary position under the cursor, such as positioning the menu with the pen tip in the center of the menu. The second into-range transition occurs when the pen tip comes into range when it is within the boundary **30** of the tracking menu **10**.

In state 1 the pen cursor moves freely about within the menu **10** and the menu **10** stays stationary. During this movement of the pen cursor within the menu **10**, the system performs conventional operations, such as highlighting buttons or controls over which the cursor passes by comparing the position of the cursor to positions of the buttons. However, if the pen is lifted out-of-range the state moves to state 0 (the pen tracking becomes inactive), if the pen encounters an edge as it moves, state 1E is entered and if the pen touches the tablet surface state 2 is entered.

To enter state 1E the position of the pen cursor (or pen tip transducer position) is conventionally compared to the position of the edges or boundary **30** of the tracking menu **10**. When a match occurs, the cursor has hit the edge and the state 1E is entered. In state 1E, as long as the cursor is at or in contact with an edge as the cursor moves, the tracking menu (semi-transparent) is moved along with the cursor. That is, as the cursor is moved, the menu **10** is conventionally redrawn with the cursor at the edge of the tracking menu. In state 1E, if the pen is lifted out-of-range the state moves to state 0, if the pen moves away from an edge to reenter the interior of the menu the state moves to state 1 and if the pen touches the tablet, state 2 is entered.

As discussed above, state 2 is entered when the pen touches **46** the tablet surface while in state 1 or state 1E. In this state the pen is active or activated such that it will cause some function to be performed. In state 2 the active pen can be selecting a button, in which case the function of the button is performed, such as selection of a new. The tracking menu does not have to become transparent while in state 2. The controls or buttons of the present invention can be designed to work such that when you press on them, they show some highlighting and the assigned function is executed only on pen-up. This allows the user to cancel their action by moving off of the button while in the pressed state and thus preventing the triggering of the function. Or the active pen can be moving while under the control of a previously selected function, such as painting with a previously selected paintbrush or zooming based on a previous selection of a zoom tool/function. In state 2, the tracking menu **10** is made fully transparent. In this state, the system can continue to reposition the fully transparent menu under the cursor or preferably the menu can be allowed to remain in it's last position as in state 0 (note the user would not perceive a difference between these two alternatives). When the pen is lifted from the tablet surface and contact with the tablet ends, the tracking mode **42** is again entered and the menu **10** is repositioned **48** depending on the last state. If the pen is lifted when the prior state is state 1E, the pen is repositioned **48** at the last edge point of state 1E. If the pen is lifted when the prior state is state 1, the pen is repositioned **48** at the last interior point of state 1.

Additional details concerning tracking operations can be found in the related application previously noted.

FIG. **4** illustrates a pen cursor or pen transducer location symbol **40** moving to the left within the tracking boundary **30** of the pen-mouse **10** and the pen-mouse **10** remaining stationary. That is, within the body of the virtual mouse **10**, movement of the sensed position **40** of the input transducer

does not cause the tracking menu **10** to move. In FIG. **5** the moving cursor **40** has encountered or hit the boundary **30** when moving to the left and the encounter with the boundary causes the pen-mouse **10** to move to the left. That is, movement of the tracking menu **10** occurs when the sensed position of input transducer **40** hits the tracking menu border **30** while the input transducer is in a "tracking state" (i.e., not during a mouse down state).

As depicted in FIG. **6**, moving the input transducer **40** over the left mouse button graphic **18** causes this sub-component to "highlight" (the faint bar **46** at the top of the left mouse button **18**). Note that the input transducer **40** is still in the "tracking" state not a "mouse button down" state. A mouse down event (pen down over a mouse button) is depicted in FIG. **7**. When a "mouse button down" state occurs with the input transducer (e.g., with a pen, the pen tip is engaged by a tapping down of the pen onto the digitizer or tablet surface), the action of the tracking menu sub-component is executed. Tapping typically implies both the pressing down and lifting up of a pen on a surface. Here, by mouse button down when a stylus is involved is meant that the pen tip comes in contact with the surface. In this case, an event for the left mouse button **18** is generated, the bar **46** can be strongly highlighted, the pen down cursor position **40** can highlighted by a visible state change, such as the hot spot star shown in FIG. **7**, to indicate that a hotspot action is occurring at the tip of the arrow cursor **16**. That is, any object, such as a menu item, at the tip of the arrow cursor or tracking symbol **16** is activated.

The pen-mouse **10** of the present invention can not only provide the traditional simple mouse tracking symbol and single mouse button functions discussed above but can also provide more complicated functions as discussed below.

Positioning the input transducer **40** over the body **50** of the mouse **10** can cause a pan tracking symbol **52** to appear as depicted in FIG. **8**. A pen down event within the mouse body subcomponent **50** of the tracking menu **10** can cause the tracking symbol **40** to change to a more bold visual state as shown in FIG. **9**. In this condition with the pan function activated, a mouse drag event (dragging the pen tip over the surface of the tablet PC or digitizer while the pen tip is touching the surface) within the mouse body **50** causes the tracking menu **10** to be dragged a distance and direction corresponding to the transducer **40** motion as illustrated in FIG. **10**.

Positioning the input transducer **40** over a bottom tab **60** of the pen-mouse **10** can causes a bar tracking symbol **62** to appear (see FIG. **11**) indicating the user is over this sub-component. Once again, a mouse down event within the mouse bottom tab subcomponent **60** of the tracking menu **10** causes the pen tracking symbol **40** to change to a more bold visual state (see FIG. **12**) and invokes the subcomponent action. In this case, the subcomponent action, as illustrated in FIG. **13** is to invoke a set of marking menus **70**. The behavior of the menus **70** matches that of the traditional marking menus. In FIG. **14**, we see the user selecting "Alt" **72** which is a "check-box" item (i.e., remains enabled until the "Alt" item is explicitly selected again to toggle the state off). A pen-up event over the "Alt" menu item turns "Alt-lock" on and feedback is provided on the body of the mouse (the "A" character **74** of FIG. **15**). A pen-down on the bottom tab again brings up the marking menu **70** (see FIG. **16**). Selecting Alt **72** again (see FIG. **17**) turns off "Alt-lock" (see FIG. **18**). Selecting "Middle" **76** from the marking menu **70** (see FIG. **19**) can turn on a "Middle-lock" (see the bar **76** of FIG. **20** indicating this state) that results in always generating a corresponding middle button mouse down/up event when any of the virtual pen-mouse buttons are engaged for a down/up action (see FIG. **19**). FIG. **20** shows both "Middle-lock" and "Alt-lock" turned on. Hovering the pen **40** over the left button **18** in this mode (as depicted in FIG. **22**) followed by a pen-down on the pen-mouse **10** left mouse button **18** in this mode can cause left mouse button **18** and middle mouse button events to be generated as depicted by the highlighted pen cursor symbol **40** of FIG. **23**. This pair of events is focused on any object at which the arrow cursor **16** is pointing. That is, initiating an event that requires a two button "click" on a mouse can be accomplished using the pen-mouse **10** of the present invention.

FIG. **24** depicts a left mouse button drag event in progress. In this operation, the user has positioned the arrow cursor **16** on top of the "Folder" icon **90** and has engaged the left mouse button **18** of the pen-mouse **10** and begun dragging the pen **40** across the tablet while the tip is touching, thereby dragging the pen-mouse that drags the folder **90**.

In FIG. **25** the user has engaged the right mouse button by placing the tracker symbol **40** over the right mouse button component **22** of the pen-mouse **10** and performing a down event with the input transducer. This results in a pop-up menu **92** appearing, in this case to the left of the arrow cursor. FIG. **26** shows dragging the pen downward (see the moved position of the highlighted pen tracking symbol as compared to FIG. **25**) and this causes various menu items to highlight (in this case the "Reset Position" item **94**) as one would expect. That is, the menu **10** can behave like a standard pop-up menu.

The pen-mouse of the present invention need not use the arrow as the tracking symbol and can have a tracking menu boundary or edge that does not coincide with the visible edge of the mouse graphic. These alternatives are depicted in FIG. **27** where the pen-mouse tracking symbol **110** is a "hotspot" type symbol and the tracking menu border **112** is a circle much larger that the graphic **114**.

The tracking symbol used with the pen-mouse, such as the arrow, can be positioned or oriented anywhere around the mouse graphic body. This choice in positioning can be designated by the user or managed by the system. For example, the system can move the arrow toward a display edge to allow easier selection of edge items. Examples of different positions for the symbol **120** are shown in FIGS. **28***a*–**28***g* and the utility or usefulness of each position includes: **28***a*—screen top edge objects, **28***b*—left handed users and top right screen edge objects, **28***c*—right edge objects, **28***d*—tom right edge objects, **28***e*—bottom screen edge objects, **28***f*—bottom left edge objects, and **28***g*—left edge objects.

The pen-mouse can have a number of different appearances, shapes or body/graphic designs. FIG. **29** illustrates a pen-mouse **130** with a different shape and different functions including a wheel where the virtual wheel can be dragged up/down and the same actions as would occur when rotating a wheel are performed. FIG. **30** depicts a pen-mouse **140** where only the buttons **142** are shown, where the tracking symbol **144** is a predetermined distance from the buttons **142** and the tracking border or boundary **146** has additional space on the right. FIG. **31** illustrates a pen-mouse **150** with traditional L, M, R buttons and modifier keys. The tracking boundary **154** is depicted by a dashed line and coincides with the mouse graphic **156**. This pen-mouse **150** includes a neck **158** attached to a base function region **60**. The neck prevents the pen tracking symbol **162**, a hot spot in this case, from accidentally triggering the functions of the base region **160**. FIG. **32** shows a pen-mouse **170** shaped like an arrow

or a dragable cursor with LMR buttons and an action hot spot at the tip **172** of the arrow. The pen tracking symbol **172** is shown in the body.

FIG. **33** shows a pen-mouse **180** in which traditional changeable cursor states are shown. The tracking or action symbol **182** may also change as a function of the system state. The tracking symbol may also not change and rather only the system cursor changes which is attached to the tracking menu mouse body.

FIG. **34** depicts a pen-mouse **190** that includes an interior tracking wall **192** jutting from the tracking boundary that coincides with of the pen-mouse graphic. When the pen tracking cursor encounters this wall **192** the pen-mouse is moved similarly to the cursor encountering the exterior tracking boundary. FIG. **35** illustrates a pen mouse **200** with a tracking boundary **202** having tracking wall **204** extending into the interior and that rotates the mouse graphic **206** when the pen cursor **208** encounters the wall **204**. This allows the pen-mouse **200** to function like a virtual track ball.

When the pen-mouse **10** of the present invention is displayed on a typical pen based computer display, the pen-mouse **10** is preferably displayed at a size similar to other tools of computer display as shown in FIG. **36**. When the pen-mouse **10** is moved about on the display is preferably maintained on top of all objects in the display including menus and other persistent objects.

The hardware of the pen-mouse tracking menu system can be within a desktop PC **230** (see FIG. **37**) or within a handheld device, such as a tablet PC **240** (see FIG. **38**) or a PDA, and includes an input transducer **250** the position of which is tracked by a computer **252** that processes the transducer positions and creates the tracking menu display that is presented on a display **254** as shown in FIG. **39**.

The system also includes permanent or removable storage, such as magnetic and optical discs, RAM, ROM, etc. on which the process and data structures of the present invention can be stored and distributed. The processes can also be distributed via, for example, downloading over a network such as the Internet.

The present invention has been described with respect to using a tablet type personal computer. The present invention is also suitable for other types of systems including large display formats (front and rear projection) both horizontal and vertical large displays, such as electronic whiteboards. Other input devices than a pen can also be used. For example, an audience could be viewing a large display presentation and if a user wants to manipulate the display from their seat, they could use a laser pointer type device. Here the pen tip down event would be generated by a dwell event or a secondary button on the laser pointer. The present invention has also been described with respect to a single input device being used with the system. The invention is also operable with two or more PenMice active at the same time, driven by two or more input devices. This allows two handed interaction techniques or collaborative multi-user applications.

The many features and advantages of the invention are apparent from the detailed specification and, thus, it is intended by the appended claims to cover all such features and advantages of the invention that fall within the true spirit and scope of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is:

1. A graphical user interface, comprising:
- a mouse graphic having the appearance of a computer mouse;
- at least one button control positioned within the graphic with a button event being produced when activated;
- a tracking symbol graphic associated with the mouse graphic and indicating event focus; and
- a tracking menu boundary providing tracking menu control of the interface for a pen type input device.

2. An interface as recited in claim **1**, wherein the tracking boundary coincides with an edge of the mouse graphic.

3. An interface as recited in claim **1**, wherein the tracking boundary comprises a safety neck.

4. An interface as recited in claim **1**, wherein the control is activated by a pen input event.

5. An interface as recited in claim **1**, wherein three button controls are provided and multiple button events can be emulated.

6. An interface as recited in claim **1**, wherein the interface can drag objects.

7. An interface as recited in claim **1**, wherein the tracking symbol graphic has an appearance corresponding to system state.

8. An interface as recited in claim **1**, wherein the tracking symbol graphic is positionable at various positions around the mouse graphic.

9. An interface as recited in claim **1**, wherein said tracking boundary comprises an interior tracking wall.

10. An interface as recited in claim **1**, further comprising one of a wheel control, a ball control, a bar control, joystick, track pad, buttons, keyboard buttons, and status indicators.

11. An interface as recited in claim **1**, further comprising:
- a second mouse graphic having the appearance of a computer mouse;
- at least a second button control positioned within the second graphic with a second button event being produced when activated;
- a second tracking symbol graphic associated with the second mouse graphic and indicating event focus; and
- a second tracking menu boundary providing tracking menu control of the interface for a second pen type input device.

12. A graphical user interface, comprising:
- a mouse graphic having the appearance of a computer mouse;
- at least three button controls positioned within the graphic with a button event being produced when activated by a stylus input event and the button controls changing appearance when activated;
- a tracking symbol graphic associated with the mouse graphic, indicating event focus and system state; and
- a tracking menu boundary coinciding with an edge of the mouse graphic and extending into the mouse graphic, and providing tracking menu control of the interface for a pen type input device.

13. A method, comprising:
- producing a graphical user interface on a display that has an appearance of a computer mouse;
- moving the graphical user interface on the display as a tracking menu responsive to movement of a pen by moving the graphical user interface when a cursor for the pen encounters a boundary of the graphical user interface; and
- interpreting input events initiated by the pen as mouse events.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,242,387 B2
APPLICATION NO. : 10/684581
DATED : July 10, 2007
INVENTOR(S) : George W. Fitzmaurice et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

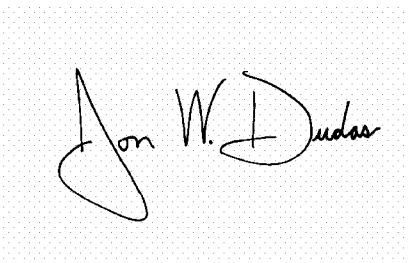
On the Title Page Item (56) (Other Publications), Line 4, change "Mochan," to --Mochon,--.

Column 1, Line 56, after "(e.g., shift/alt)" insert --.--.

Column 2, Line 27, after "activation" insert --.--.

Signed and Sealed this

Fourth Day of December, 2007



JON W. DUDAS
Director of the United States Patent and Trademark Office